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ABSTRACT

One area explored in the Learning in Science Project (Primary--LISP(P)--was children's questions about and explanations of phenomena. Data were obtained from work with classes of children, interviews with children, informal discussions with teachers, and observations of two teachers using an alternative teaching model (outlined in an appendix) which builds on questions children have and explanations that they suggest. Children's responses to this approach suggests that they: can identify a communication system which encourages them to ask questions; are able to decide which questions interest them most; will accept questions which are not their own; and appreciate lessons based on their questions. In addition, variations in the number of questions asked by children and in the number of children asking questions were found. Other findings are presented and analyzed in relation to: (1) features of children's questions (such as questions serving different functions for different children); (2) six aspects of children's explanations (including the finding that children's answers give insight into the way they interpret a question); and (3) teachers' reactions to science as inquiry (such as teachers being surprised at the sophistication of children's questions and answers). Implications of these findings for further research are outlined. (JN)

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LEARNING IN SCIENCE PROJECT (PRIMARY)

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SOME ISSUES RELATING TO CHILDREN'S QUESTIONS AND EXPLANATIONS

Science Education Research Unit
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SE 045 308

Working Paper No.106

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Fred Biddulph, Roger Osborne,

November 1982

A Working Paper of the Learning in Science Project (Primary)

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INTRODUCTION

It has been suggested (Symington, Osborne, Biddulph & Freyberg, 1982) that children's questions and explanations should be carefully investigated since they are an important means by which children attempt to make sense of their world. Preliminary attempts to probe children's thinking in these areas are described in the above paper. The purposes of this paper are to report certain issues which seem to arise out of further exploratory investigations in these areas, and to set forth considerations for in-depth research which appear to be indicated by the issues.

Data from which the issues have been drawn were obtained in four main ways, namely work with classes of children, interviews with children, informal discussions with teachers, and observation of two teachers taking science lessons. During September - November 1982, one of us (F.B.) worked with classes of children from seven Hamilton and five Christchurch primary schools in their usual classroom settings to gain the chidren's questions and answers on certain science topics. Similar work was also done with a class of children from an Auckland primary school who were brought to an in-service course in that city. The approach used was to present the children with stimulus material (eg. letting them handle pieces of rock), to invite their questions on the topic, to publicly record these on the blackboard, and to have the children in groups or individually - as they preferred - write what they considered the answer(s) might be to one of the questions specified by the researcher. Additional question and answer data was obtained from three Hamilton primary school classes when the class teachers introduced science lessons in a similar manner. In about six classes the children were also invited to comment on the alternative approach to science that they had just experienced.

In respect of interviews, eight children from one of the classes and ten children from another of the classes were interviewed either individually or in pairs, or in one case in a group of three - depending on whether they had worked alone or with a partner or in a group of three - the following day to investigate their method of checking on their proposed

answers, and the criteria they used to decide whether other answers were 'good' ones or not.

Details of the classes from which both types of data were obtained are shown in Table 1.

Table 1 Primary school classes that generated questions and answers

TOPIC	CLASSES
space	S.3
electricity/magnetism	S.4
animals	S.2, S.3, S.4
metal	S.2, S.3/4, S.4, S.4, S.4, S.4
skeletons	S.3, S.3, S.3, S.3/4, S.3/4
plastic	S.2/4, S.3, S.3/4, S.4*
spider	S.2/3♯, S.4♯, S.4, S.4, S.4
rock	S.2/3, S.3/4, S.3/4, S.4
seeds	S.3*
clay	S.2*
slaters	S.2

* These classes were taken by their regular teacher.

♯ Children from these classes were interviewed the following day.

During the 'lessons' taken by the researcher, most of the teachers remained to observe and they assisted by making a written copy of the children's questions. At the conclusion of some of these 'lessons' comments on the approach used, its effects on the children, and its possibilities for teaching were either spontaneously given by, or were sought from, the teachers.

TOWARD A TEACHING MODEL

While 'lessons' which explore children's questions and explanations are valid from a research point of view, such 'lessons' may of themselves lead into a useful set of lessons and hence provide a worthwhile teaching

model. This issue has been explored theoretically by us and the model of Appendix 1 is proposed as a possible teaching strategy which builds on the questions which children have and the explanations that they suggest. The model is largely untried but theoretical support for it can be found in Alton-Lee and Haberfield (1982), in Barnes (1976), in Blough (1975), in Duckworth (1971), in Hurley (1975), in the ideas of Isaacs (Hardeman, 1974), in Kessan (1975), in Rowe (1973) and in the work of Suchman (described in Joyce and Weil, 1980; Rowe, 1973).

For any particular topic it is unclear how much support would need to be given to a typical teacher for the model to work successfully. For example, it is unknown how much background information will need to be given to the teacher on the questions children are likely to ask, explanations they are likely to offer, the research proposals that they are likely to suggest and how the teacher can support these, and so on. During November, 1982, two teachers used the model without any such support.

Procedures and responses during the first lesson on 'plastics' and the first three lessons on 'seeds' were noted or audio-recorded, and informal discussions with both teachers were held before and after the lessons.

CHILDREN'S RESPONSE TO THE ALTERNATIVE TEACHING APPROACH

It has been noted elsewhere (Biddulph, 1982b) that in classroom situations which are characterised by teachers trying to instil teacher-determined knowledge into children the children seldom ask questions of the content. In contrast, when the communication system (Barnes, 1976) is altered so that the teacher genuinely tries to understand the children's ideas instead of making value judgements about the children, the children will respond by asking questions, even if their first experience of the alternative teaching approach is with a researcher who is a stranger to them.

1. Children quickly identify with a communication system that encourages them to ask questions.

Within the space of a half-hour 'lesson' children at the Std.2-4 level had little difficulty in recognising the new expectations contained in the alternative teaching approach, and in all cases responded by asking questions. This occurred whether the 'lesson' was taken by the researcher or by the class teacher and indicates that the first stage of the model is likely to be practicable and manageable.

2. There was a variation in the number of questions asked by children and a variation in the number of children asking questions.

The total number of questions asked by children in thirty-one separate sessions was 519, giving a mean number per session of almost 17. Although the number of children in each class varied, this cannot fully explain the fact that the number of questions asked per session varied from 6 to 35. It must be asked whether there are other factors influencing the number of questions being asked. For example, is the age of the children, and hence the experience and skills that they can utilize, a factor? In the case of 'metals' it was the S.2 children who generated the least number of questions (7 questions) and the S.4 children who generated the most (14-20 questions). In an earlier investigation of children's questions Baker (1969 p.24) reported that,

> "the number of questions asked may have been influenced by the attitude of the teacher and the general atmosphere of the classroom."

This could be true of the present study also. On the topic 'plastics' it was a S.3 class which was usually dominated by the teacher trying to convey knowledge to the children that generated the least number of questions (7 questions). The class which generated the most questions on this same topic (19 questions) was a S.4 class taken by their own teacher using the alternative science teaching model. This raises a further question: will children respond with a greater number of questions if taken by their own teacher using the alternative teaching model than if

taken by a stranger such as a researcher? Does the nature of the topics themselves influence the number of questions asked by children? The number of questions asked about 'plastics' ranged from 7 - 19 whereas the number of questions asked of 'skeletons' ranged from 19 - 28. Similarly, the number of questions asked of 'metal' ranged from 7 - 20 whereas the number of questions asked of 'spider' ranged from 14 - 35. This is consistent with a finding by Baker (1969) who reported that elementary children are most interested in animal life and very interested in the construction and function of the human body. Finally, does the type or method of stimulus presentation affect the number of questions asked? Although two S.3 classes asked 19 questions and 20 questions respectively after looking at pictures of skeletons, and another two S.3 classes asked 19 questions and 23 questions respectively after looking at pictures of skeletons and model of a human skeleton, it is possible that the four classes would have asked a greater number of questions had they been clear that the purpose of looking was to think of questions. On the other hand, their response suggests that they would have this expectation on subsequent occasions. To what extent such direction of observation to the presented stimuli would restrict children using their wider experiences as a question base is unknown. Furthermore, the extent to which children may come to ask questions as a means of aquiring social rewards rather than out of genuine curiosity (Day and Berlyne, 1971) cannot even be guessed at. However, with these considerations in mind there could be merit in investigating the minimum stimulus required to enable children to generate an adequate number of genuine questions on a topic. Since primary teachers are confronted by many curriculum areas they would be more likely to accept an approach that did not seem to involve elaborate preparation and equipment.

Information is available on the percentage of children asking questions in twelve of the classes. This shows a range of 24% - 57% with a mean of 45%. Although the 24% was the S.2 class children who looked at real slaters and the 57% was a S.4 class who looked at real spiders it is not clear that age is a factor as 36% of the children in one S.3 class asked questions about 'skeletons' whereas 56% of the children in another S.3 class asked questions on the same topic, and 48% of the children in a S.3/4 class also asked questions about 'skeletons'. The other factors

previously mentioned could all have some bearing on this issue. So too could the reward structure, evaluative cimate (Doyle, 1980) and the social interaction pattern that normally exists in the classroom. For example, a competitive climate in which children are prone to criticise each other in a negative manner is not likely to be conducive to children asking questions (Suchman, 1971).

3. Questions stimulate questions and stimulate children's interest in a topic

When the children were asked what questions they might have, they responded as a class in a manner which became predictable. One or two children usually had questions to begin with and these seemed to suggest further questions in the minds of other children, so that in the end up to about half the number of children in a class might have asked a question. In other words, the interaction process seems to be important in generating children's questions. At the same time a significant number of children in the classes did not ask questions. Just why this was so is not known although some hint of what could be involved was provided by a S.3 boy. At the conclusion of one 'lesson' in which half the class of thirty children asked 28 questions the boy said that he had been trying to think of a question to ask but he just couldn't think of one. Why some children are able to ask several questions and others cannot think of any would be worth exploring further. Is it possible that children who have difficulty or are initially unsuccessful at generating questions can be helped to do so? What conditions are necessary for them to sustain the propensity if and when it is developed?

At the conclusion of a few of the 'lessons' some of the children said that they hadn't really thought much about a particular topic until other children began asking questions about it,

"You don't really think about it much." (S.3 child)
"You just take these things for granted." (S.3 child)

and then it seemed really interesting,

"It's interesting and it makes you think." (S3 child)

Thus it would seem likely that the teacher could introduce any topic which the pupils could relate to with the probability that children would develop an interest in it if their questions formed the basis of the study. It should be noted, however, that some topics could be of greater interest to children than others. If the number of questions asked by children is an indicator or topic interest - and it may not be - then 'plastic' (mean No. of questions = 12), 'rock' (mean No. of questions = 15) and 'metal' (mean No. of questions = 16) are not quite as interesting topics to children as 'spiders' and 'skeletons' (both mean No. of questions = 22).

4. Children are able to decide which questions interest them most

After the children's questions were recorded in twenty-one of the 'lessons', the children were asked to consider which question interested each of them the most. They had little hesitation in making a choice but the basis of this choice is not known except in one case where a child said,

> 'I thought it's better to get the one question that all of them originated from."
>
> (S.4 boy)

Some questions were obviously more popular than others. In 16 out of the 21 'lessons' three-quarters or more of the children in each class chose among them just four questions as the most interesting. In the remaining 5 'lessons' between 60% and 70% of the children chose four questions as the most interesting. From a teaching point of view this would suggest a more manageable situation than one in which most of the children expressed diverse interests.

The questions on a topic that interest children the most do not necessarily lead in the direction specified in the unit on that topic. For example, on the topic 'spiders' children are particularly interested in how spiders produce poison which doesn't poison themselves, and how

they produce silk in which they don't get caught themselves. They are also interested in why spiders have so many eyes and legs. The unit on the other hand, while mentioning silk, tends to emphasize habitat and the place of spiders in the food chain.

It would be fair to say that some questions on a topic which interest children could lead in the direction indicated in the unit on that topic. For example, on the topic 'metals' children are interested in the discovery, number of types and production of metals which, taken together, have something in common with the unit emphasis on sources of metal.

5. Children will accept questions which are not their own

The observations of the preceding section indicate that children will accept questions asked by their peers in that class. It seems likely that the children will accept questions of peers from other classes as well. On one occasion the researcher introduced to a class the question, "Why do rocks have different colours?" which had been asked by children the same age during a previous 'lesson'. This question was accepted by the class as an interesting question. They then wrote 26 different answers to it. It is also possible that children will accept as their own a question asked by an adult but probably only if it has meaning for them, is percieved as genuine and as being asked from a communication status position equal to the children. On another occasion the researcher observed a lesson in which S.3 children generated 31 questions on 'seeds'. When these had been recorded by the teacher the researcher suggested that he would like to know, "Do animals have seeds inside them?" Two groups of children in the class asked their teacher to write this question on the board as they considered it the most interesting of all the questions and wanted to use it as the basis of their study.

The fact that children can become genuinely interested in questions which are initially not their own would suggest that teachers would have some flexibility in guiding the children's studies in directions that, for various reasons, the teachers considered worthwhile. What is not known

are the factors that enable a child to identify a question as meaningful, and what is also unknown is the point at which questions posed by an adult cease to be meaningful to a child.

6. Children appreciate lessons based on their questions

When children have been asked at the end of a 'lesson' by the researcher or by their teacher what they thought of the lesson they have invariably replied that they enjoyed being able to ask questions and to base their work on questions that interested them. As one child said,

> "You can choose something that you haven't already learnt and that you can learn, what you want to learn about."
> (S.4 girl)

The approach is apparently thought provoking,

> It's good to make you think, and you can come up with some ideas and then you can think it's not correct, and you keep on trying."
> (S.3 child)

In this situation children learn things from each other, although they do not necessarily recognise the source of their learning as indicated by the response of another S.3 child who thanked the researcher for what he had taught her during a 'lesson'.

Obviously the novelty effect of the approach cannot be discounted but it would seem that if children's questions provided the basis of science lessons conducted along inquiry lines then their interest in science might be sustained and the gap between school knowledge and everyday knowledge (Barnes, 1976) narrowed. The West Leyden High School, Illinois, ten year experience using a variation of this approach to secondary students learning science (Riban, 1976) and Duckworth's (1972) contention that children's intellectual development lies in their testing out ideas which they find significant, support this suggestion.

FEATURES OF CHILDREN'S QUESTIONS

1. Questions seem to serve different functions for children

(a) Confirmation of an expectation

Some of the questions asked by children, but not many, suggest that the children have an idea of the likely explanation and are seeking confirmation of it, e.g.

> "Why do animals get born with camouflage that can protect them from other animals?"
> (S.4 child)

(b) Resolution of an unexpected puzzle

A substantial number of questions asked by children indicate that they recognise that an expectation which they held no longer seems to be valid, and they'd like to make sense of the phenomenon involved, e.g.

> "If gold is a metal, how come it can't be picked up by a magnet?"
> (S.4 child)

In this case the child's concept of metal, or expectations regarding its properties, seem to be contradicted by observation, and the child wants an explanation.

(c) Fill a recognised knowledge gap

Perhaps a majority of children's questions are of this type, e.g.

> "How do fish get air out of the water with their gills?
> (S.3 child)

> "How does the animal's brain work?"
> (S.2 child)

Undoubtedly these classes of function proposed by Isaacs (Hardeman, 1974) may be overlaid with other analytical networks. For example, through their questions children may be seeking a description of quality, they may be seeking a purpose, a general rule, a cause, an analogy, or a description of a procedure of some object or action. What is required is

some means of analysing children's questions and explanations so that the children's basic beliefs and belief-forming processes are revealed (Confrey, 1981).

2. Some questions are not valid questions

A few of the questions asked by children contain invalid assumptions in a scientific sense, e.g.

> "How does the radio transmission get turned into electricity as it doesn't have any power when it comes onto the aerial?"
>
> (S.4 child)

but they could nevertheless provide the basis for children's study if they were interested in them. In the course of the study they would probably learn a lot about the phenomena and come to realise that the question wasn't a good one.

3. Some questions jump beyond the topic

A number of questions that children ask (7 out of 31 on the topic 'seeds') relate to aspects that may have only a tenuous link with the topic under consideration, e.g. one of the questions asked on the topic 'seed' was,

> "What is the biggest tree in the world?"
>
> (S.3 child)

A teacher is likely to require information about this feature of children's questions if s/he is to be adequately prepared to deal with them. It will happen that some children consider such a question the most interesting, e.g. during the same lesson on 'seeds' one group of children chose to work on the question:

> "Can there ever be a money tree?"

4. Children sometimes use themselves as a reference point

Some questions asked by children indicate that the children are thinking of the phenomenon in human terms, e.g.

"How can dogs runs so far without getting puffed?
(S.2 child)

The proposed science teaching model certainly allows such questions to be asked and to be accorded equal status with other questions. Whether some children, for example Polynesian children, use this mode of thinking more extensively than other children is not known but could be worth investigating.

5. Children ask a number of common questions on various topics

After analysing the questions asked by children in four or five clases on the same topic it is apparent that a number of similar questions are being asked. Common questions that arose during lessons on 'spiders', 'metals', 'plastic', 'rock' and 'skeletons' are listed in Appendix 1. The fact that common questions are asked is likely to be helpful to teachers in that, knowing what to expect, they can have some advance ideas as to how they can handle them. It may also indicate that a number of children have constructed similar belief systems, perhaps based on similar experiences, but this would need to be investigated.

ASPECTS OF CHILDREN'S EXPLANATIONS

1. Children have plenty of ideas about possible answers to their questions

After children's questions have been recorded in a 'lesson' the children have then been asked to write what they think the answer(s) might be to one or two specified questions. The children have been invited to work on their own, with a partner, or in a group of three - whichever they prefer - to accomplish this task. Invariably each group could write one

or, more often, two or more answers to the question(s) posed. This is consistent with a finding by Oakes (1969) who, after investigating the nature of children's explanations, reported that children gave many types of explanations for each question.

2. Children's answers give some insight into the way they interpret the question

Children do not necessarily take from a question the meaning that a teacher would predict. Further, different children seem to take different meanings from the same question. Their answers give a clue to their interpretation, e.g. with respect to the question, "How are rocks made?" the child who answered,

By other rocks joining together."

seemingly interpreted the question in terms of the process involved in rock formation whereas the child who answered,

"Metal"

apparently interpreted the question in terms of the material from which s/he thought rock is formed. Similarly with respect to the question, "Where does metal come from?" some children's answers indicated tht they interpreted the question to mean a country ("Mostly North America"), or a natural place ("Caves"), or the material from which it is obtained ("Dirt"), or the means by which it is obtained ("It's mined").

3. Children give some common answers to certain questions

When 'lessons' were conducted with five separate classes at the S.3/4 level on 'skeletons' the opportunity was taken to have the children respond to a similar question. All classes answered a variation of the question, "Why do creatures have skeletons?" and the answers of the children in the five classes made reference to movement ("So you can move"), to support ("They have to hold our bodies up.") and to protection ("It protects our squashy insides").

In a single class many of the groups will write a similar answer, e.g. in one class which answered the above question on 'skeletons' eight of the groups (that is, about half of the children) wrote an answer that related to a support function.

4. Children can suggest ways of checking the validity of answers

After the children had written their answers and listened to them as they were read to the class by themselves or the teacher - again, whichever they preferred - they were asked how they could check whether their answers were good ones or not. Almost all the classes suggested three ways, namely consulting reference materials, consulting knowledgeable people, and carrying out some activity such as observation or 'experimentation'. A few classes suggested a fourth way; take a vote on it!

Initial observations of some children working at checking answers in the school setting, and brief discussions with a few children who had tried to do the same at home, indicate that while the children approach the task with enthusiasm they probably require considerable guidance over time to develop the skills necessary to carry out the task to their satisfaction. It is an area that also requires further investigation.

5. Children have ideas about whether certain answers are good ones or not

When children have been interviewed the day after a 'lesson' they have had little hesitation in expressing a view about various answers to a question. Occasionally a child said that s/he didn't know what to think about an answer, usually because a word in the answer was not understood, but most often the children would say that an answer was, or was not, a good one and would support their view with a reason that made sense to them, e.g. one question was, "Why do spiders have so many eyes?" In commenting on the answer, "Because they have small eyes' one child said,

> "Yeah, that one would do. Because there are so many of them, they have to be small eyes 'cos if they have big ones they'd look silly."
>
> (S.4 child)

Little investigation has been done on this aspect of children's thinking, namely the criteria that they use to accept or reject various answers or explanations, and yet it would seem to be an area that is central to children's development of ideas and their attempts to make sense of their world.

TEACHER REACTION TO SCIENCE AS INQUIRY

The particular research/teaching approach adopted by the researcher to gather information on children's questions and explanations was designed to enable children to engage in the process of inquiry with respect to the phenomena presented. When the researcher arrived to take the 'lessons' a few teachers took the opportunity to attend to other matters but most remained and were invited to write a copy of the children's questions and observe what happened.

1. Teachers have often been surprised at the sophistication of children's questions and answers

At the conclusion of a number of the lessons the teachers have expressed surprise at what they perceive to be the highest quality of some of the questions asked, e.g,

> "How come big birds can go higher than little birds when they are heavier?"
>
> (S.2 child)

and some of the answers given by the children, e.g.

> "Well, it's (skeleton) like a roll cage in a stock car; it protects you."
>
> (S.3 child)

particularly by children who do less well on formal academic work.

2. Teachers have shown considerable interest in the approach used

Many of the teachers who remained in the classroom during the 'lesson' not only recorded the children's questions but also moved about listening to groups of children as they formulated their answers. In addition to the expressions of surprise mentioned above, a number of the teachers said that they intended to follow up the work either by discussing with the children during the next day or so their efforts at checking on their answers, or by taking up with the children some of the other questions that they had asked. A few teachers intended to alter their programmes that same day to do so.

Two teachers, one an experienced teacher and one a first-year teacher, have gone a step further and taken a science unit of their own using the inquiry approach. Both experienced difficulty at first in putting aside their own questioning of the children to provide a classroom communication system consistent with student inquiry. One of the teachers went to the extent of writing the following self-reminder note at the top of her planning page: "Don't ask questions!" In the event, both teachers did manage to avoid cross-questioning the children and they found that the children sustained a high level of interest throughout the study. An analysis of audio tape-recordings of children at work in groups in one of the classes during three lessons revealed that the children's talk and activities were on target virtually the whole time. Both teachers modified the teaching model to suit their own needs as they saw them but it is significant that despite a theoretical backbround in science education and experience in science education research, both teachers needed the concrete steps made explicit in the alternative teaching approach to enable them to translate their understanding into a teaching sequence that matched their understanding. It should be mentioned that both teachers appeared to have excellent rapport with their children and neither had any really disruptive pupils in their class.

It would appear that primary science that places greater emphasis on children and their learning than on the transmission of science content is likely to find favour among primary teachers who, as a science adviser

mentioned, tend to believe that teaching should begin with finding out where the children are at in terms of the knowledge and experience that they bring to a topic.

WHAT ARE THE IMPLICATIONS OF THE ISSUES FOR RESEARCH?

Within the context of an alternative teaching approach it has been found that children can generate a considerable number of questions and explanations, they have thoughts about which questions and answers are most interesting, they have ideas about which questions and answers are 'good' ones, they are able to suggest a number of ways of checking explanations, and they have expressed appreciation at having science lessons based on their questions. For their part, teachers can see the possibilities in science lessons based on children's questions but to translate the possibilities into practice they seem to require the guidance of a model that clearly specifies teaching steps. Obviously considerable work remains to be done on articulating the teaching model and determining its applicability. Joyce and Weil (1980) provide indicators of how this might be done. This will need to be the focus of later research. Of more immediate concern is research which will provide teachers with needed information for use with the model. Issues to which such research will need to be addressed include the following:

1. Children's questions

* What factors motivate children to ask questions?
* What do children need by way of an intellectual basis to enable them to ask questions?
* What function(s) do the asking of questions serve with primary children, particularly in relation to their belief systems and expectations?
* What do children mean by the questions they ask?
* Why do some children experience difficulty in formulating questions?
* Could children be helped to formulate questions if the processes were understood?
* What are the processes involved in children's question-asking?

* How does children's question-asking relate to learning?
* What factors enable children to identify with questions that are not their own?
* How committed are children to their questions?
* On what basis do children choose questions as being most interesting?
* Can a child be curious, even committed to learning about a topic, without asking questions about it?

2. Children's explanations

* How committed are children to their explanations?
* On what basis do they propose answers?
* What criteria do they use to accept or reject explanations?
* How do these criteria relate to their belief systens?
* How does the generation of explanations by children relate to their learning?

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APPENDIX 1

PROPOSED PRIMARY SCIENCE TEACHING MODEL

Step 1: CHILDREN IN INTERESTING SITUATION

A situation that stimulates the children to ask questions related to a science topic.

Step 2: CHILDREN'S QUESTIONS ON THE TOPIC

These could be publicly recorded e.g. on the board.

Step 3: CHILDREN'S SUGGESTED ANSWERS TO A QUESTION

These could be written on paper by the children either individually or in groups and if desired then also listed on the board.

Step 4: CHILDREN'S RESEARCH PROPOSALS

At this step the children either individually or in groups write a research proposal outlining:

(a) the question/answer they are going to check on
(b) how they are going to check on it
(c) where they are going to check on it
(d) how long they estimate they will take
(e) what equipment they will need

Teacher approval will be necessary before children embark on Step 5. (A teacher may decide to accept some proposals that are doomed to failure but from which children will learn something useful.)

Step 5: CHILDREN'S RESEARCH ACTIVITY

The children conduct an inquiry on <u>their</u> problem using <u>their</u> suggested activity. This may be

(a) observation or 'experiment'
(b) consulting books
(c) consulting knowledgeable people

Step 6: CHILDREN'S RESEARCH REPORT AND PEER COMMENTS

The children report their findings to the rest of the class.
The other children, with teacher guidance, comment on

(a) whether or not the group or individual had really found out what they were trying to find out
(b) possible alternative explanations
(c) other studies that might follow

APPENDIX 2

QUESTIONS WHICH CHILDREN COMMONLY ASK ON VARIOUS TOPICS (S.2-4 level)

'SPIDERS'

Aspect	Question (example)
types	How many known spec es are there?
poison	How do they produce poison? How do they get the poison into the insects and kill them and not us?
silk	How do they get all the stuff to make their web?
eyes/legs	Why do spiders have eight eyes? Who do spiders have so many legs?
food	What do they eat?
habitat	Who do some live underground?

(Note: 'food' and 'habitat' questions are not as common as the others.)

'METALS'

composition	What are metals made of?
production	How are metals made?
colour	Why are they different colours?
number	How many sorts of metals can you get?
discovery	Who discovered metal?
melting point	What temperature does metal melt at?

'PLASTIC'

composition/origin	What is plastic made of? Where does it come from?
shape	How do they get it into the shape?
colour	How do they get the colouring into plastic?
hardness	How do they make it hard or soft?
thickness	How do they get the different thicknesses?
writing	How do they get the writing onto plastic?
coating	How do they get the coating on to things?
melting	Why does it melt

APPENDIX II (Continued)

'ROCK'

composition	What are rocks made of?
colour	How do they get their colour?
hardness	Why are they hard?
shape	How do rocks get their shape?
weight	Why are some rocks different weights than others?
texture	Why are rocks sometimes smooth and flat? Why do rocks have holes in them?

'SKELETONS"

function	Why do creatures have skeletons?
number of bones	How many bones has a person got?
composition	What are bones made of?
becoming a skeleton	How long does it take the flesh to go off the skeleton?
identification	How do you tell which sort of skeleton it is? How can you tell if a skeleton is a girl or boy?
structure	What actually joins the bones together?

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